

Expanding the Giovanni Holdings for LCLUC and Climate Studies over Monsoon Asia Regions

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<http://disc.gsfc.nasa.gov/mairs>

Abstract

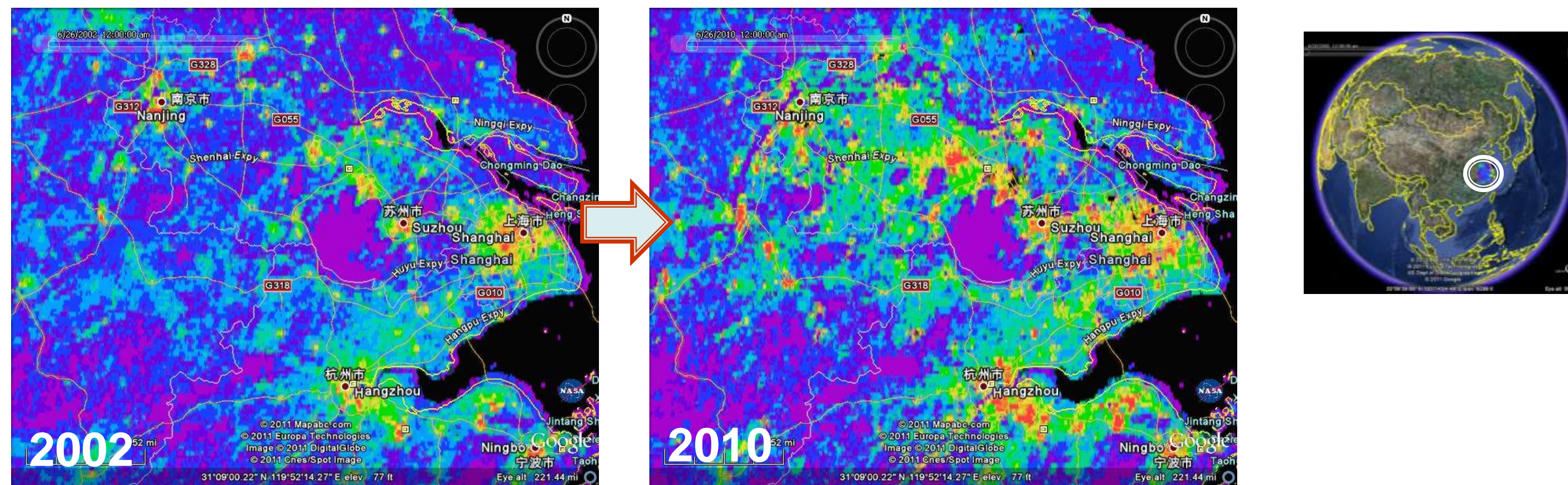
The MAIRS project at NASA GES DISC (Goddard Earth Sciences Data and Information Services Center) has been collecting satellite and model data since the spring of 2009 to support the Monsoon Asia Integrated Regional Study (MAIRS) program. Giovanni (Goddard Interactive Online Visualization AND aNalysis Infrastructure) MAIRS portals have been created, enabling scientists to explore, analyze, and download data easily without needing to learn the original data structure and format. Products of satellite observations from multiple sensors (MODIS, AIRS, AMSR-E, SeaWiFS), and assimilation models (land: GLDAS, atmosphere: MERRA, ocean biology: NOBM) have been integrated into the system.

Recently, the Giovanni MAIRS portals have been expanded, focusing on:

- Integration of land products at 5km (global) and 1km (MAIRS region), such as MODIS land surface temperature, vegetation index, and land cover type;
- Integration of global monthly climatology data of selected products (precipitation, aerosol, and greenhouse gases, etc.) and anomaly analysis functions;
- Work with the MAIRS regional partner to develop a system for accessing Giovanni images dynamically from a remote Web server by using advanced online data sharing technology and Google Earth interface.

Due to the large overlap of geographic coverage and many similar scientific interests of the MAIRS and NEESPI programs, archived data in the system can be served for both programs.

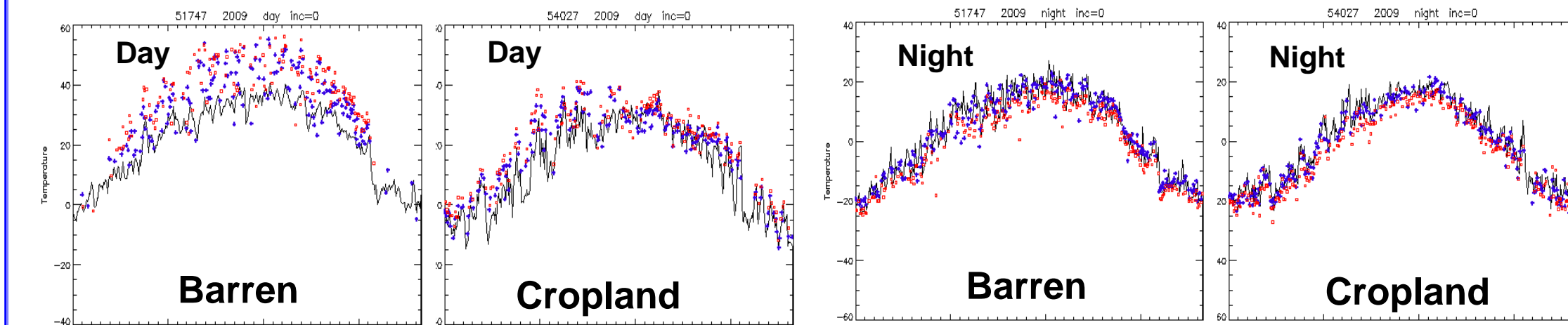
8-Day 1km Land Surface Temperature Recent Land Surface Temperature Changes over Eastern China



Averaged MODIS-Aqua 1km resolution daytime Land Surface Temperature (LST), July-August 2002 and July-August 2010 over Yangtze River Delta region, eastern China, indicating significant warming in the rapid urbanization zone. Images are generated with Giovanni and displayed in Google Earth. Available LST products in Giovanni are processed from MOD11A2.005 and MYD11A2.005, covering MAIRS region (0° – 60°N, 60°E – 150°E).

Estimation of Surface Air Temperature from MODIS Land Surface Temperature

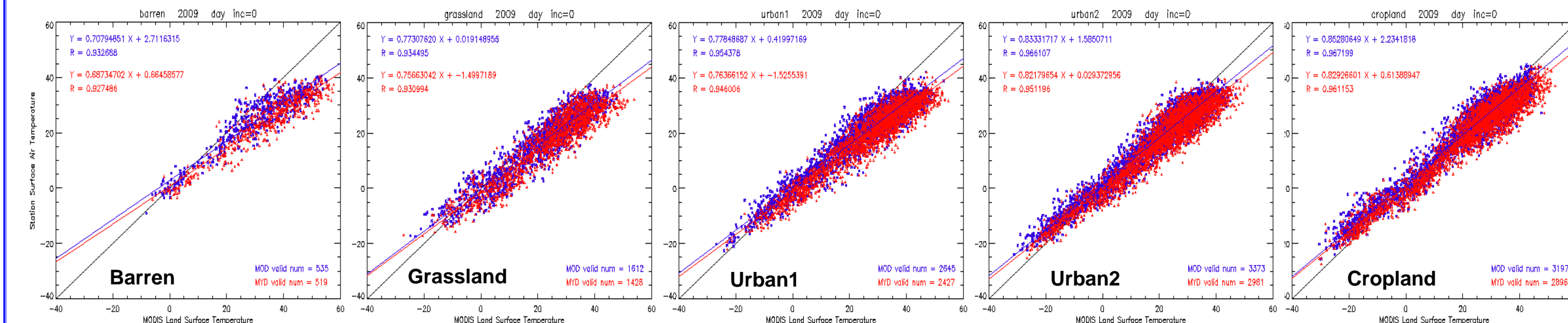
Surface air temperature data (T_a) obtained from meteorological stations are distributed sparsely in many regions, which is insufficient coverage for higher resolution regional models. This study investigates the possibility of estimating 1km resolution minimum T_a ($T_{a_{min}}$) and maximum T_a ($T_{a_{max}}$) from MODIS LST over the dry and semi-arid region of northern China by using data from 75 stations and daily LST from MODIS-Terra (MOD) and MODIS-Aqua (MYD).



Sample time series of T_a (line) and LST from MOD (blue) and MYD (red) for day and night over Barren and Cropland

$T_{a_{max}} - LST_{day}$	r	mean	STD	$T_{a_{min}} - LST_{night}$	r	mean	STD
barren	0.9327	-6.0503	5.7060	barren	0.9432	-0.0805	4.2127
grassland	0.9345	-4.900	5.2733	grassland	0.9517	0.4218	3.9739
cropland	0.9672	-0.5128	4.6506	cropland	0.9640	0.1168	3.9961
urban-1	0.9544	-4.7396	5.0828	urban-1	0.9647	-0.971	3.7380
urban-2	0.9661	-1.3790	0.8333	urban-2	0.96627	-0.586	3.8152

Tables show correlation coefficient (r), mean, and standard deviation (STD) between T_a and LST from MOD (slightly different from MYD, not shown). urban-1 and urban-2 are for stations where the maximum monthly mean NDVI < 0.4 and NDVI > 0.4, respectively.



Scatter plots and linear regressions between $T_{a_{max}}$ and LST_{day} over five different surface types.

In Summary:

- MODIS land surface temperature of daytime (LST_{day}) and nighttime (LST_{night}) from both MODIS-Terra and MODIS-Aqua are correlated significantly ($p=0.001$) with surface daily minimum and maximum air temperatures ($T_{a_{max}}$ and $T_{a_{min}}$); the correlation is higher in winter than in summer;
- The mean difference between LST_{night} and $T_{a_{min}}$ is smaller than that between LST_{day} and $T_{a_{max}}$;
- The linear regression of LST_{day} vs. $T_{a_{max}}$ depends on land surface type and vegetation index (VI) – the same parameters for LST_{night} vs. $T_{a_{min}}$ do not depend on land surface types; and
- Estimated air temperatures (T_a) are computed using linear regression equations for each surface type, which brings the slope to 1 and offset to zero. The root mean square (RMS) between T_a and T_a' is about 3.7 °C for minimum and 3.8 °C for maximum temperatures, combining data from both Terra and Aqua reduces the RMS.

Parameters in Giovanni MAIRS

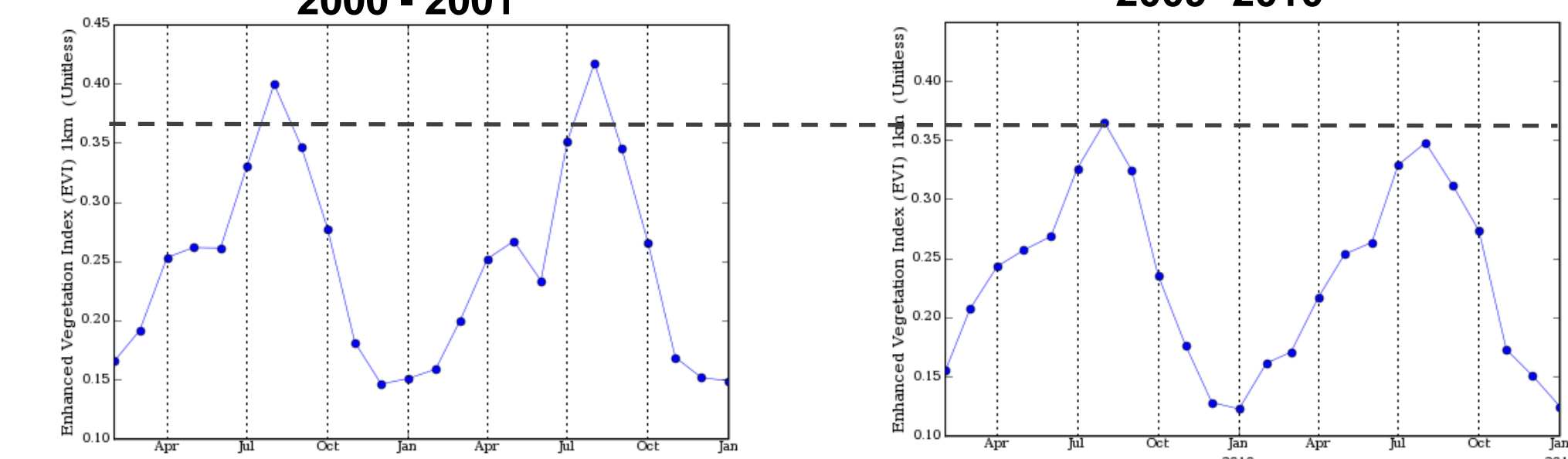
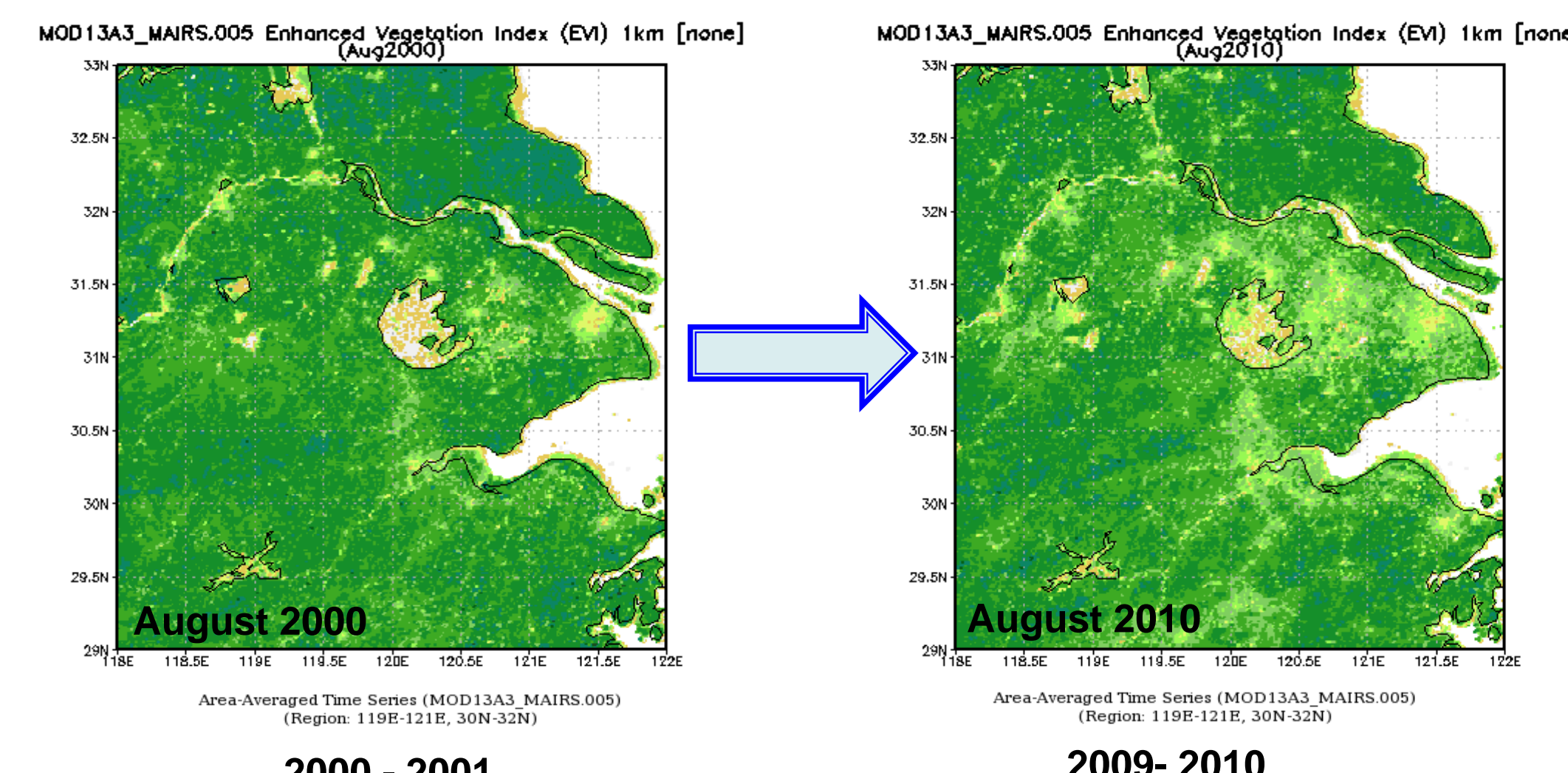
<http://disc.sci.gsfc.nasa.gov/mairs/visualization>

Group	Parameter Name	Sensor/Model	Available Since	Time Interval	Spatial res.(deg)
Meteorology & Atmospheric Chemistry	Winds, Pressure, Geopotential Height, Air Temperature, Water Vapor	MERRA	1979.01	Monthly	2/3 x 1/2
	GPCP precipitation	GPCP	1979.01	Monthly Daily	1.0x1.0
	Aerosol Optical Depth	MODIS	2000.02	Monthly Daily	1.0x1.0
	NO ₂	OMI	2004.08	Daily	0.25x0.25
	CH ₄ , CO, CO ₂ , O ₃	AIRS	2002.08	Monthly Daily	1x1
Land Surface	Land Cover Type & Dynamics	MODIS (MOD12Q1)	2001	Yearly	5 km 1km
	Vegetation Indices	MODIS (MOD13A1)	2000.03	Monthly	1.0x1.0 1 km, 1 km
	Land Surface Temperature	MODIS (MOD11A2)	2001.03	Monthly 8-Day	1.0x1.0 1 km
	Thermal anomalies/Fire	MODIS (MOD14A2)	2000.03	Monthly 8-Day	1.0x1.0 1 km
	Total Evapotranspiration, Snow Water Equivalent	GLDAS	1979.01	Monthly	1x1
	Surface Runoff, Soil Moisture	GLDAS	1979.01	Monthly	1x1
	Chlorophyll a concentration	SeaWiFS	1997.09	Monthly	9 km
Ocean	Sea surface temperature	MODIS-Terra	2000.02	Monthly	9 km
Socio-economic	Nighttime Lights	DMSP-OLS	1992-2003	yearly	1 km

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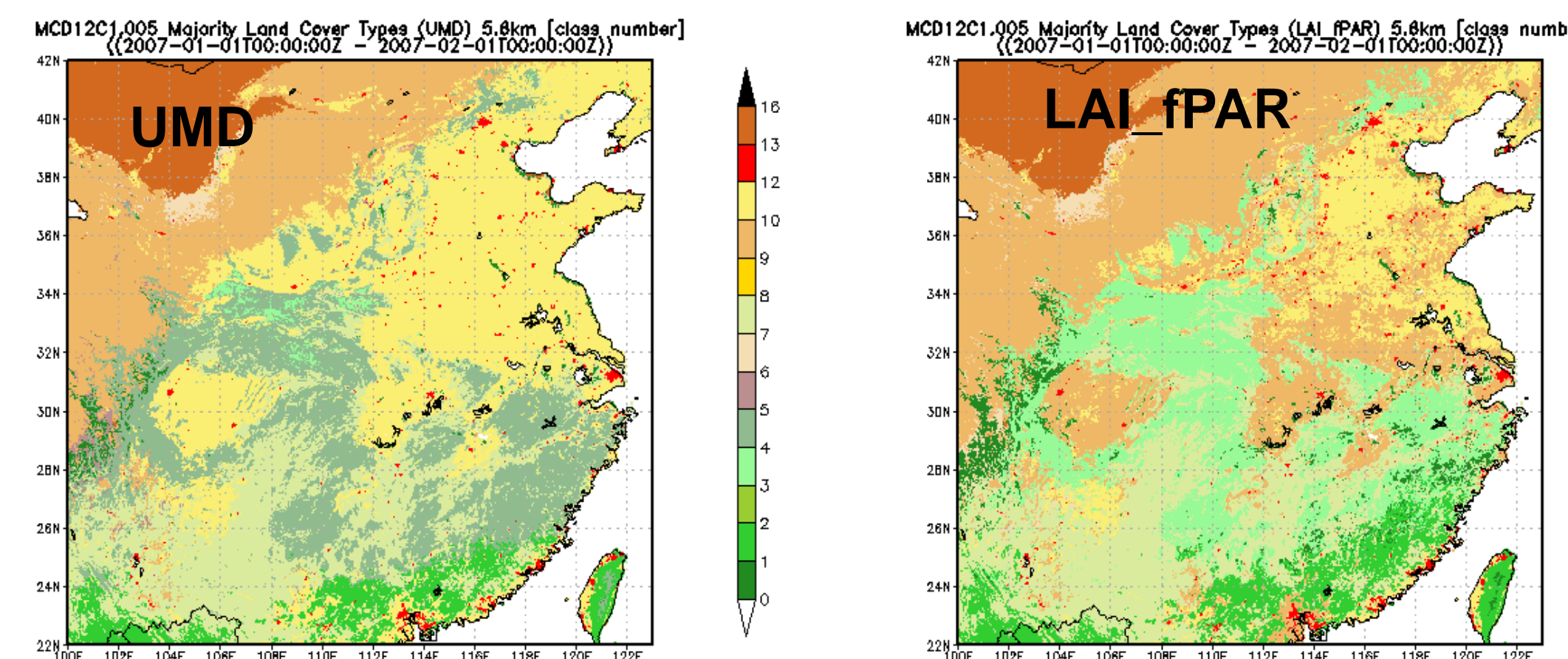
Monthly 1km Vegetation Index



Above images show that the monthly enhanced vegetation index (EVI) from MODIS-Terra 1km resolution products over Yangtze River Delta region, eastern China, decreases significantly during the past ten years, reflecting land cover and land use changes in this fast-developing region. Available vegetation index (EVI and NDVI) products in Giovanni are processed from MOD11A3.005 and MYD11A3.005, covering the MAIRS region (0° – 60°N, 60°E – 150°E).

Global Yearly 5.6 km Land Cover Types

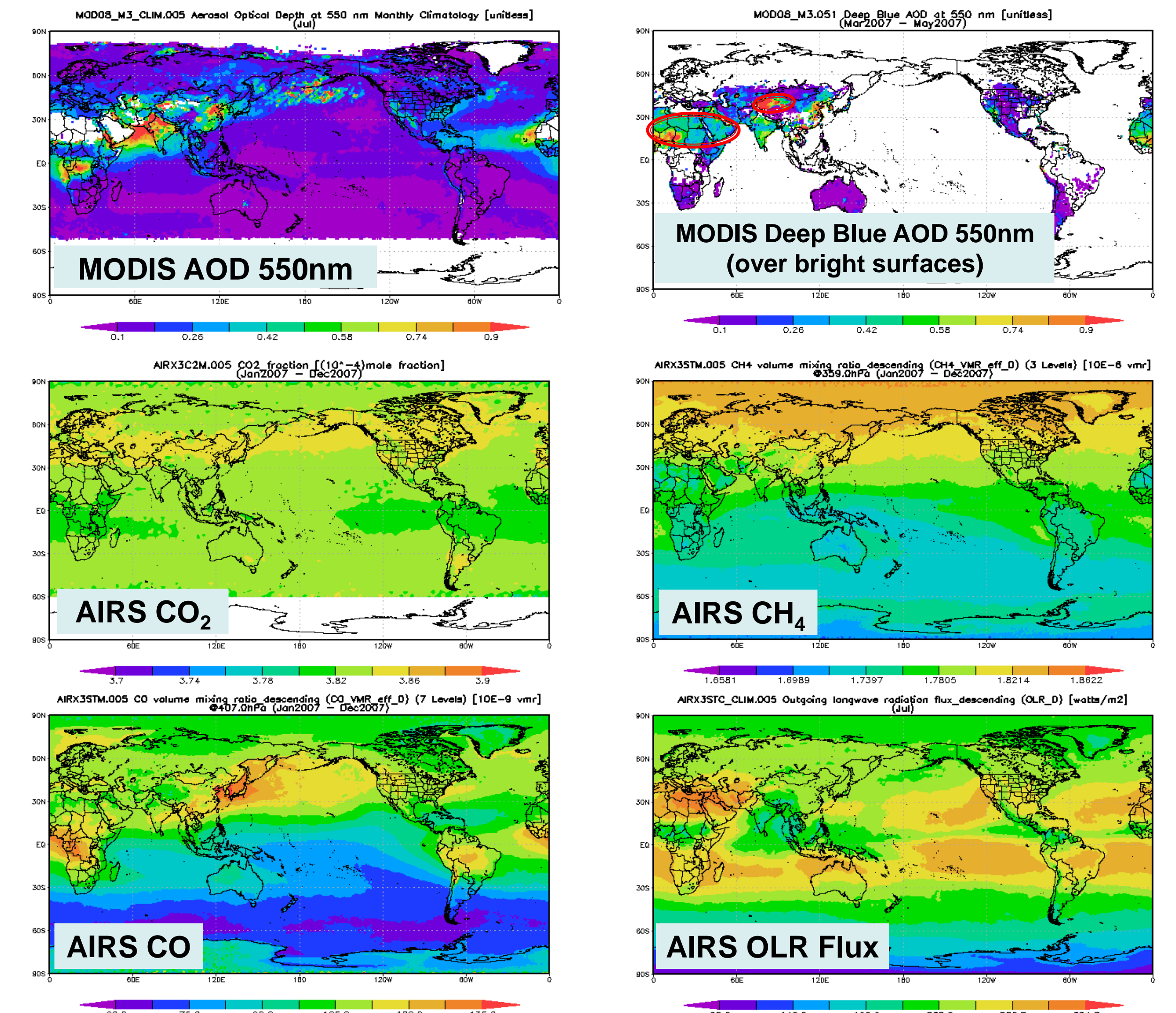
The global yearly MODIS combined land cover type classifications (IGBP, UMD, LAI fPAR) at 5.6km (MCD12C1.005) has been integrated into Giovanni system (in test). The sample images are UMD and LAI fPAR classifications generated by Giovanni. The system allows to extract digital data easily for any interested area. The 1km data generated from MCD12Q1.005 at MAIRS region (0°-60°N, 60°E-150°E) will be added next. The different land cover type classifications can be used for different applications.



Class	UMD	LAI/fPAR	Class	UMD	LAI/fPAR
0	Water	Water	5	Mixed forest	Evergreen Broadleaf forest
1	Evergreen Needleleaf forest	Grasses/Cereal crops	6	Closed shrublands	Deciduous Broadleaf forest
2	Evergreen Broadleaf forest	Shrubs	7	Open shrublands	Evergreen Needleleaf forest
3	Deciduous Needleleaf forest	Broad-leaf crops	8	Woody savannas	Deciduous Needleleaf forest
4	Deciduous Broadleaf forest	Savanna	9	Savannas	Non-vegetated
			10	Grasslands	Urban
			12	Croplands	
			13	Urban and built-up	
			16	Barren or sparsely vegetated	

Aerosols, Greenhouse Gases, and More

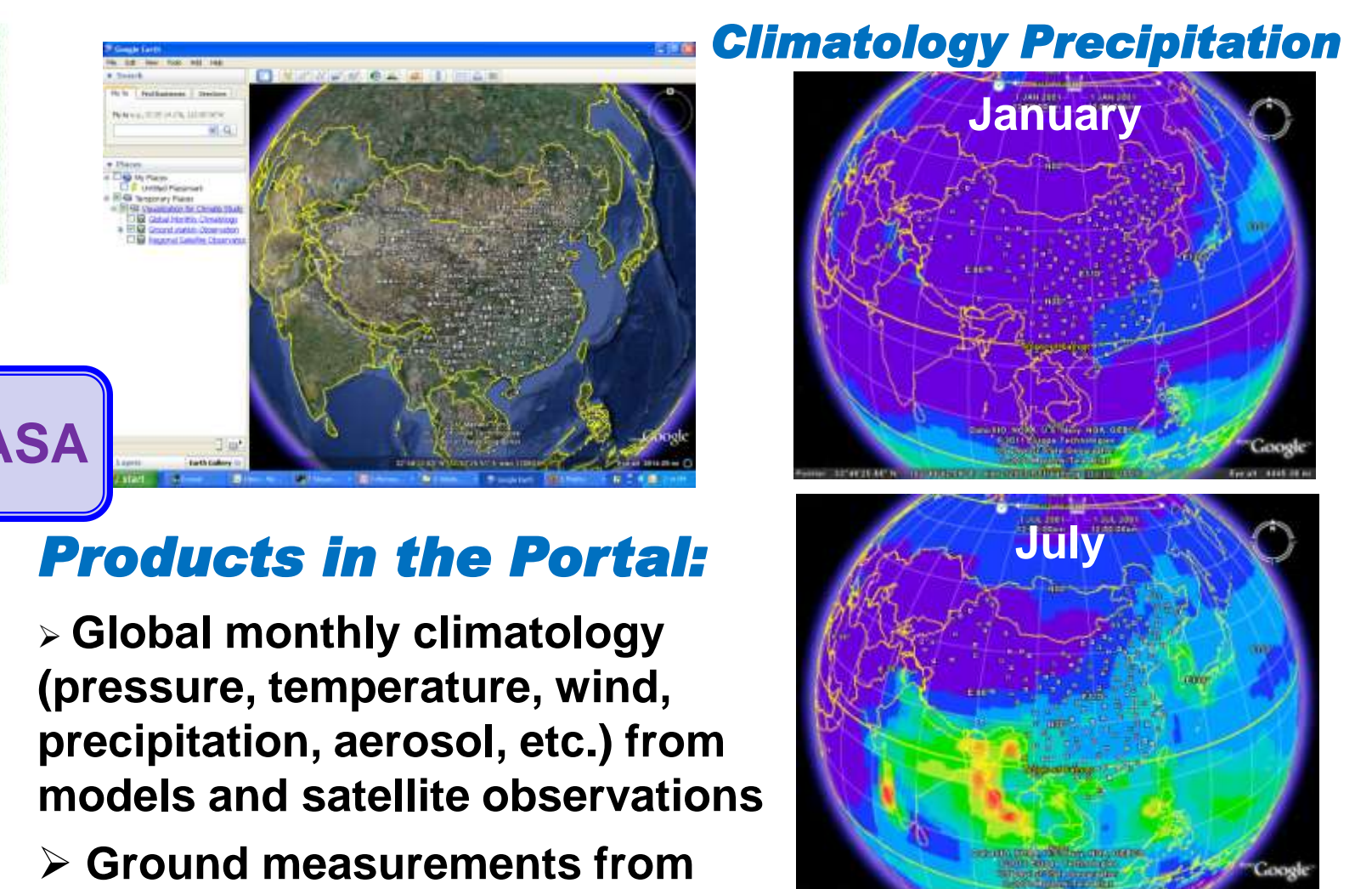
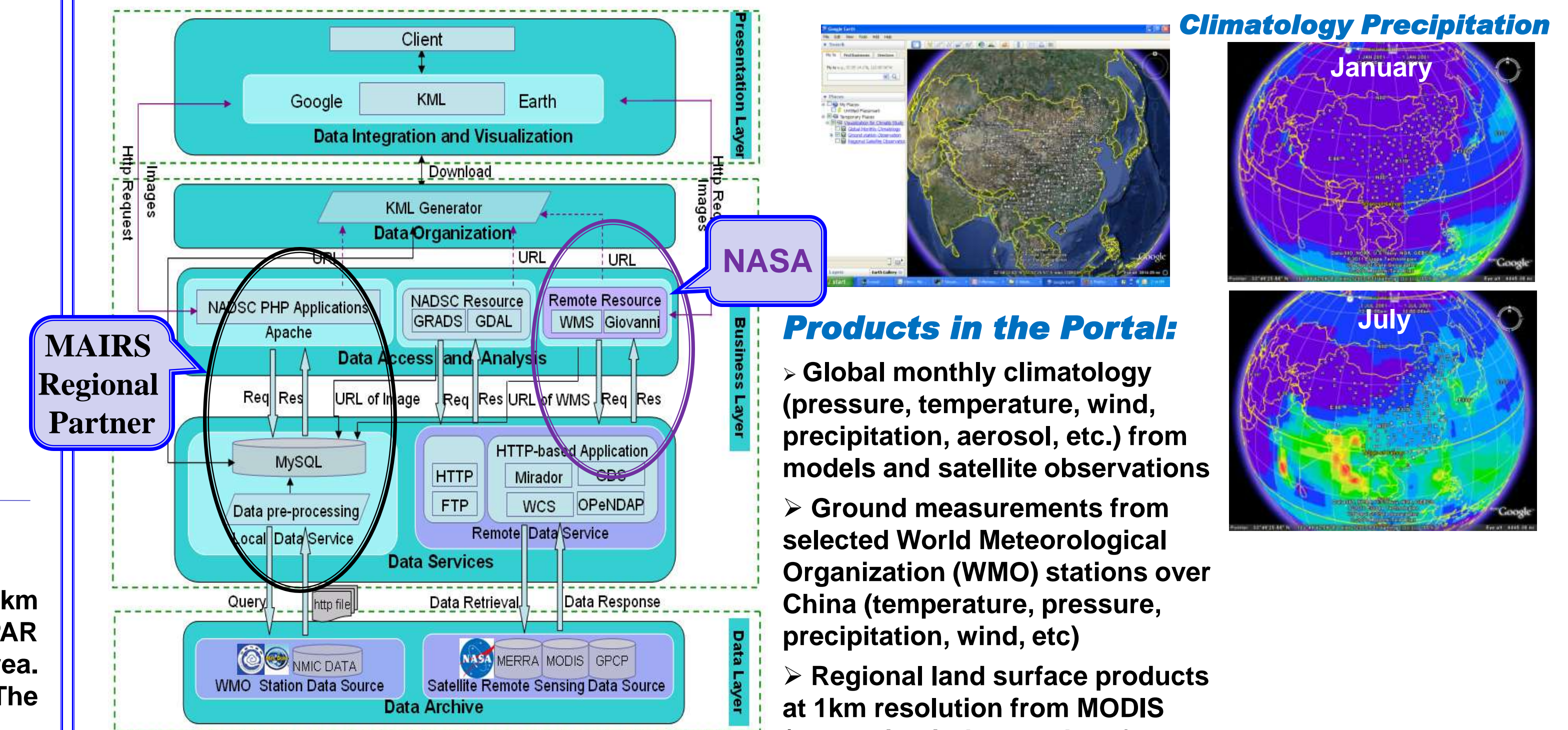
Below are sample images from the Giovanni MAIRS portals for climate studies. The MODIS Deep Blue AOD at 550nm from the latest version (V5.1) fills gaps over desert in the standard MODIS AOD product. Greenhouse and other trace gases that are associated with climate variation (such as CO₂, CH₄, and CO) have recently been integrated into the system.



Google Earth Portal for Climate Data Visualization

<http://nadsc.nuist.edu.cn/mairsprogram/data/mairs.kml>

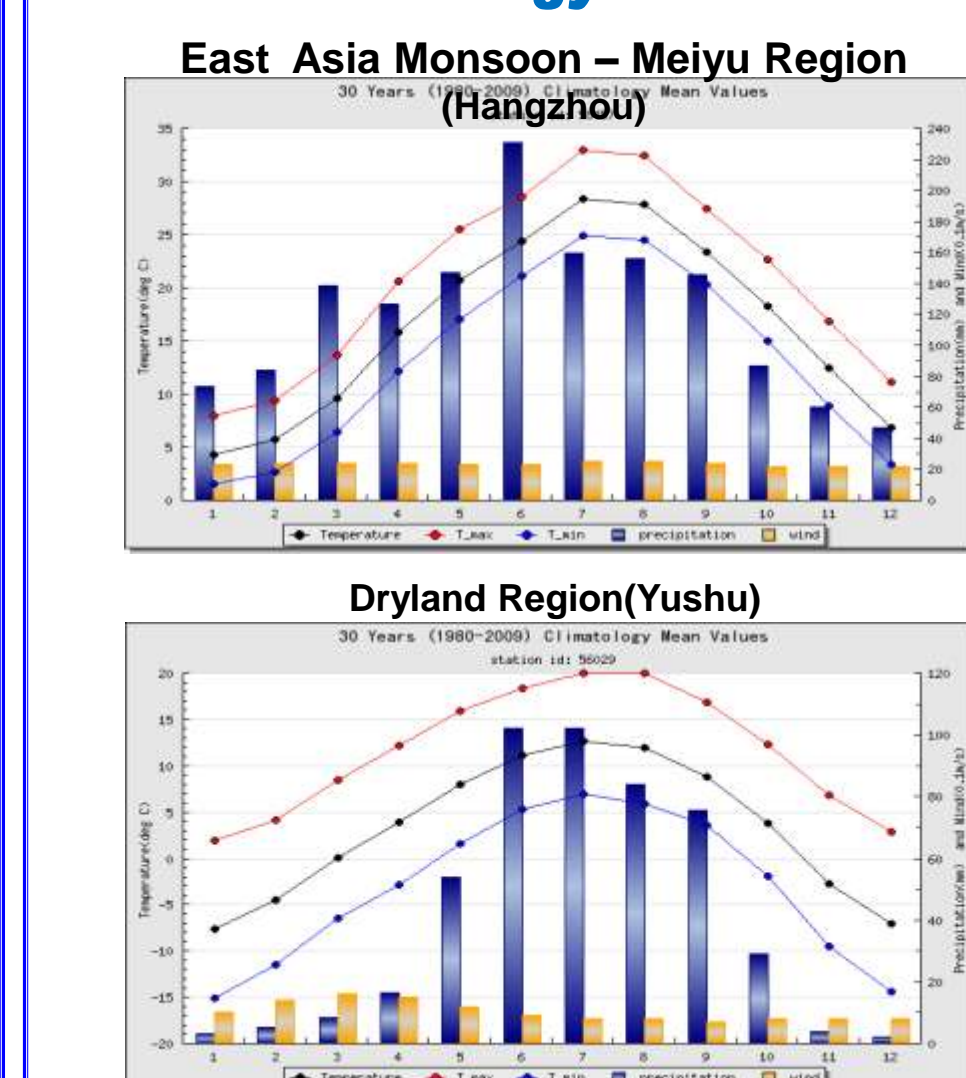
A Web-based visualization prototype has been developed by using Google Earth and online data sharing technologies, such as WMS, GDS, and OPeNDAP. The system has been installed at Nanjing University of Information Science & Technology (NUIST), China, a MAIRS regional partner. Users can simultaneously access the station data archived on the local server (NUIST) and remote sensing and model data from NASA, along with Google Earth geographic information, to conduct climate studies.



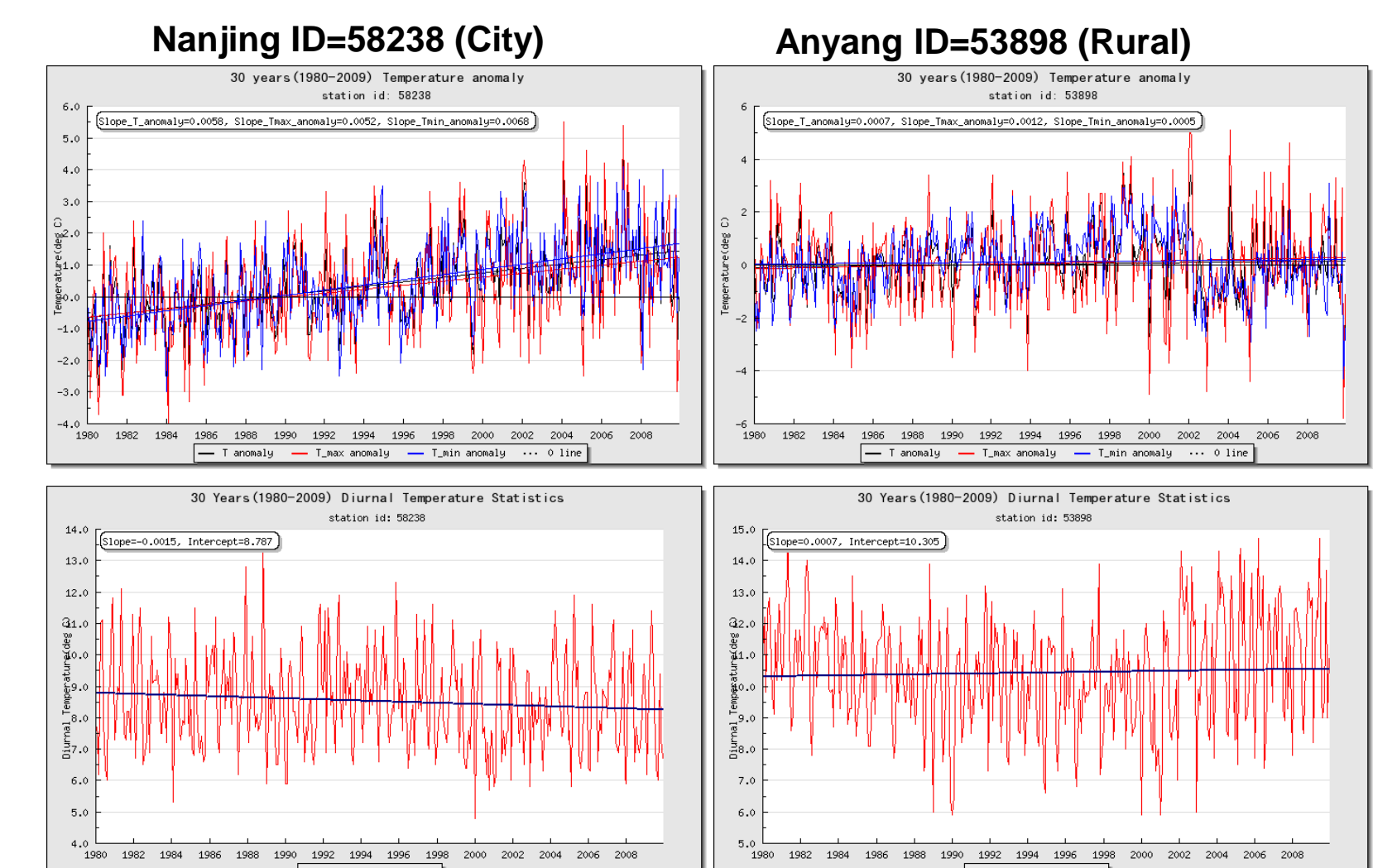
Products in the Portal:

- Global monthly climatology (pressure, temperature, wind, precipitation, aerosol, etc.) from models and satellite observations
- Ground measurements from selected World Meteorological Organization (WMO) stations over China (temperature, pressure, precipitation, wind, etc)
- Regional land surface products at 1km resolution from MODIS (vegetation index, land surface temperature)

Climatology Time Series



Anomaly and Diurnal Temperature Range



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